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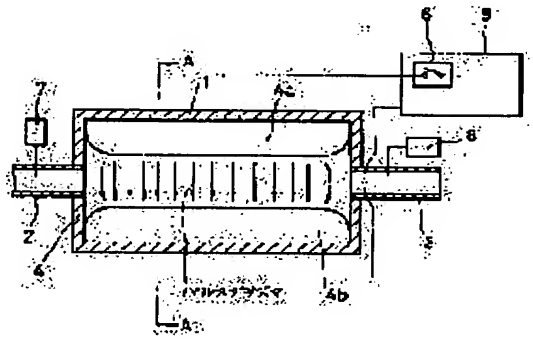
(54) WASTE GAS TREATING DEVICE

(57)Abstract:
PURPOSE: To obtain a compact and safe waste gas treating device excellent in denitrating capacity by introducing a waste gas into a plasma generation vessel, impressing a monopulse electric field on an electrode from a high-voltage pulse power source against a gas current to generate non-equilibrium plasma having a high electron temp. in the passage and further controlling the pulse repetition frequency.
CONSTITUTION: An inlet pipe 2 and an outlet pipe 3 are connected to a treating vessel 1, discharge electrodes 4a and 4b are oppositely provided in the vessel, and a high-voltage pulse power source 5 contg. a trigger pulse controller 6 as the control part is connected to the discharge electrode 4. A flowmeter 7 is provided on the gas inlet side and a gas sensor 8 on the gas outlet side, and the signals are inputted to the controller 6. Gaseous NOx are introduced into the vessel 1, a monopulse high electric field is impressed to generate non-equilibrium plasma having a high electron temp. in the passage, and NOx are ionized, dissociated and removed. The high-voltage pulse string is controlled by the controller 6 to control the pulse repetition frequency proportional to the treating flow rate or NOx concn.



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CLAIMS

[Claim(s)]
[Claim 1] The processing container with which exhaust gas circulates the interior, and the flowmeter and gas sensor which were arranged in the circulation way of said exhaust gas, respectively, The high-voltage pulse power source which is attached in said processing container and which impresses a high-voltage pulse to the electrode for plasma generating of a pair, and the electrode for plasma generating of this pair at least, The exhaust gas processor characterized by constituting by the pulse control section which controls the pulse output frequency of said high-voltage pulse power source according to the detecting signal of said flowmeter, or the detecting signal of a gas sensor.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the exhaust gas processor from which the nitrogen oxides (NOx) under smoke eliminating of an internal combustion engine, an incinerator, etc. are removed using the short pulse glow discharge of an adjustable repetition frequency.
[0002]
[Description of the Prior Art] In internal combustion engines, such as a diesel power plant, a gas engine, and a gas turbine engine, NOx occurs by combustion. When it roughly divides as this cure against NOx reduction, there are fuel conversion, a combustion improvement, and exhaust gas denitrification. Among these, in fuel conversion and a combustion improvement, a limitation is in the reduction effectiveness of NOx (20% - 50%), and it is hard to respond to toughening of regulations of the Clean Air Act etc.
[0003] There are dry process and a wet method as said exhaust gas denitrification technique, and the selective catalytic reduction process (the ammonia denitrogenizing method is called below) of a wet method is used with current [sufficient]. The ammonia denitrogenizing method is contacted for the denitrification catalyst which poured in ammonia into exhaust gas and was installed down-stream, and decomposes NOx into harmless nitrogen and water by the reduction reaction shown below. As a catalyst, V2O5-WO3-TiO3 system is in use.
[0004] The 3->2-N2of 4NO+4NH3+O2 ->4N2+6H2 ONO+NO2+2NH(s)+3H2O ammonia denitrogenizing method uses ammonia harmful as a reducing agent, and dangerous, in addition is using the hydrocarbon and the carbon monoxide. Moreover, as a catalyst used for this reaction, the various metallic oxides which noble-metals systems, such as Pt, aluminum2O3, TiO2, etc. were made to support are raised, and ammonia is always consumed, and exchange of an expensive catalyst etc. is further needed by degradation of the reduction catalyst engine performance by ammonia gas.
[0005] Moreover, there is an exhaust gas processor which used the discharge plasma as a dry process.
[0006]
[Problem(s) to be Solved by the Invention] There is a trouble shown below by the ammonia denitrogenizing method mentioned above.
[0007] (1) In order to decompose NOx, harmful and dangerous ammonia gas must be used.
[0008] (2) Since the reduction catalyst engine performance by ammonia gas deteriorates, need exchange of an expensive catalyst etc. and the actuation is troublesome.
[0009] (3) The range of the service temperature of the conventional reduction is restricted with 320-450 degrees C. That is, at an elevated temperature, sintering of catalyst nature advances, the catalyst engine performance deteriorates by the phase transition of a crystal, below 320 degrees C, it reacts with ammonia gas and the exhaust gas with which moisture contains SOx, an acid ammonium sulfate etc. is produced, and denitrification performance degradation is produced.
[0010] (4) In order to pour in ammonia gas almost equal to the amount of NOx into exhaust gas according to the rate of denitrification, an ammonia chemical cylinder, a catalyst, etc. become large-sized, and the miniaturization of the whole equipment is difficult.
[0011] Moreover, in the exhaust gas processor using the discharge plasma which is dry process, since it was difficult to maintain a discharge condition (a corona and glow discharge) to fluctuation of the flow of exhaust gas and it difficult to control the plasma to a flow rate or concentration while it was difficult to enlarge a plasma field, therefore it was unsuitable for large flow rate processing, improvement in denitrification capacity was not able to be aimed at.
[0012] This invention aims at aiming at improvement in the rate of denitrification by using the short pulse

glow discharge of an adjustable repetition frequency in view of an above-mentioned trouble.
[0013]
[Means for Solving the Problem] The processing container with which exhaust gas circulates the interior in order that this invention may attain the above-mentioned purpose, The flowmeter and gas sensor which were arranged in the circulation way of said exhaust gas, respectively, The high-voltage pulse power source which is attached in said processing container and which impresses a high-voltage pulse to the electrode for plasma generating of a pair, and the electrode for plasma generating of this pair at least, The pulse control section which controls the pulse output frequency of said high-voltage pulse power source according to the detecting signal of said flowmeter or the detecting signal of a gas sensor constitutes an exhaust gas processor.
[0014]
[Function] Exhaust gas is led to a plasma generating container, short pulse electric field are impressed to an electrode from a high-pressure pulse power source to a gas stream, nonequilibrium plasma with a high electron temperature is generated all over passage, this ionizes or dissociates exhaust gas, and NOx is removed. Pulse repetition frequency is controlled according to a processing flow rate or an NOx concentration value.
[0015]
[Example] The example of this invention is explained below, referring to drawing 1 - drawing 5 .
[0016] Drawing 1 and drawing 2 show the exhaust gas processor by the example of this invention, in this drawing, 1 is a processing container and the introductory tubing 2 for introducing exhaust gas and the delivery tube 3 which derives the gas after processing are connected with this processing container 1. Inside the processing container 1, discharge electrodes 4a and 4b are opposite-**(ed). 5 is a high-voltage pulse power source, builds in the trigger pulse controller 6 which is a pulse control section, and is connected to discharge electrodes 4a and 4b. 7 is the flowmeter formed in the gas inflow side, changes a flow rate detecting signal into an electrical signal, and leads this electrical signal to the trigger pulse controller 6 of the pulse power source 5. Moreover, 8 is the gas sensor formed in the effluence-of-gas side, changes a detecting signal into an electrical signal, and leads it to the trigger pulse controller 6.
[0017] In the exhaust gas processor shown in drawing 1 and drawing 2 , NOx gas is led to the processing container 1, short pulse (200 or less ns) high electric field are impressed to the upper and lower sides or both sides to a gas stream, nonequilibrium plasma with a high electron temperature is generated all over passage, thereby, it ionizes or dissociates and NOx is removed. A high-voltage pulse train controls the pulse repetition frequency proportional to a processing flow rate by the trigger pulse controller 6.
[0018] The configuration of discharge electrodes 4a and 4b is considered as the long and slender arrangement along the flow direction of gas, and in inter-electrode, the small thing of electric-field distortion is desirable, for example, is the Chillan mold, a LOGO skiing mold, or an parallel monotonous mold. Moreover, the standup of the pulse from a pulse power source shall be steep (100 or less ns). Let control of a repetition frequency be the frequency which changed reading of a flowmeter 7 into the electrical signal, and performed it, or changed the value of NOx concentration into the electrical signal with the gas sensor 8, and was proportioned in the value.
[0019] That is, as shown in the processing system of drawing 3 , after NOx gas is led to the processing container 1 and processed by the pulse plasma, it is drawn from the processing container 1. A flow rate value is detected by the flowmeter 7 on the occasion of the inflow of NOx gas. After this detection value is changed into an electrical signal, it is inputted into the trigger pulse controller 6. Moreover, the value of the NOx concentration in the raw gas drawn from the processing container 1 is detected by the sensor 8, and this detecting signal is inputted into the trigger pulse controller 6.
[0020] The trigger pulse controller 6 supplies a control signal to the high-voltage pulse power source 5 according to the detecting signal of a flowmeter 7, and it generates the pulse output of the frequency according to the NOx concentration of a gas sensor 8 while generating the pulse output of the frequency proportional to a flow rate. Here, the repetition frequency of a pulse changes in proportion to a flow rate, and a frequency is better as about 50Hz to an upper limit is high. Moreover, although the pulse power source for pulse generating and the switching element of a trigger pulse controller have a discharge control switch or a good field effect transistor, as long as it can perform high-speed switching, other things are sufficient as them.
[0021] According to the example shown in drawing 1 - drawing 3 , the following effectiveness is acquired.
[0022] (1) Impressing the steep short pulse height electrical potential difference which starts can generate the glow discharge plasma in the condition that an inter-electrode electrical potential difference is high, and

a plasma field is widely made rather than arc discharge.
[0023] (2) The steep glow discharge which starts (100 or less ns) can generate the plasma with a high electron temperature, and processing effectiveness improves.
[0024] (3) It can carry out to processing of a few flow rate to a large flow rate, without changing a plasma treatment container by changing the repetition frequency of a pulse to a processing flow rate.
[0025] (4) Processing energy efficiency improves by controlling a frequency according to the NOx concentration of exhaust gas further.
[0026] Drawing 4 and drawing 5 show the exhaust gas processor by other examples of this invention, and the same sign is given to the same as that of the thing of drawing 1 - drawing 3 , or a considerable part.
[0027] In this example, the both sides of a flowmeter 7 and a gas sensor 8 are established in the gas installation side of the processing container 1. That is, the flowmeter 7 and the gas sensor 8 are formed in the introductory tubing 2, and the detecting signal of these flowmeters 7 and the detecting signal of a gas sensor 8 are inputted into the trigger pulse controller 6.
[0028] As shown in the processing system of drawing 5 , the flow rate value detecting signal of the introductory gas by the flowmeter 7 and the NOx concentration value detecting signal of the introductory gas by the gas sensor 8 are inputted into the trigger pulse controller 6. The trigger pulse controller 6 controls the high-voltage pulse power source 5 based on either or the both sides of these detecting signals, the frequency of the pulse plasma generated between discharge electrode 4a and 4b is controlled, and the same operation as the thing of the above-mentioned example and effectiveness are acquired.
[0029]
[Effect of the Invention] This invention is like the above, and while leading exhaust gas to a plasma generating container, impressing short pulse electric field to an electrode from a high-pressure pulse power source to a gas stream and generating nonequilibrium plasma with a high electron temperature all over passage, since pulse repetition frequency is controlled according to a processing flow rate or an NOx concentration value, it can obtain the exhaust gas processor which the whole equipment made it small, and was excellent in safety, and was excellent in denitrification capacity.

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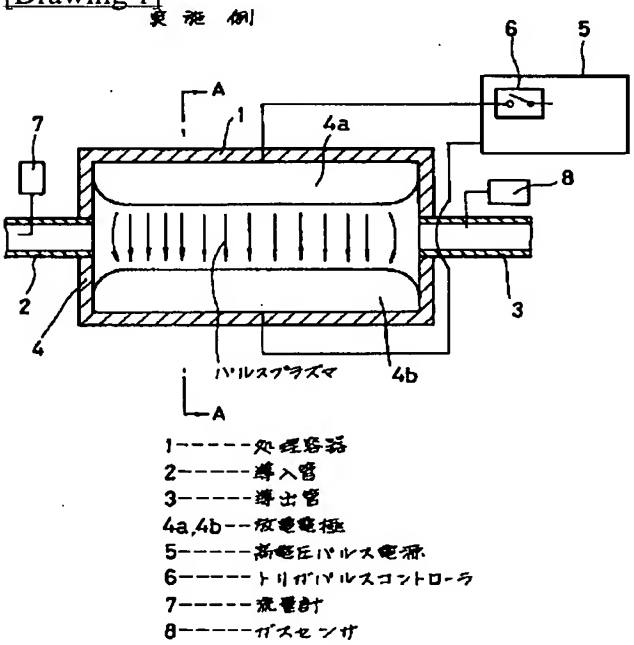
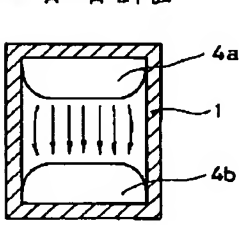
DRAWINGS

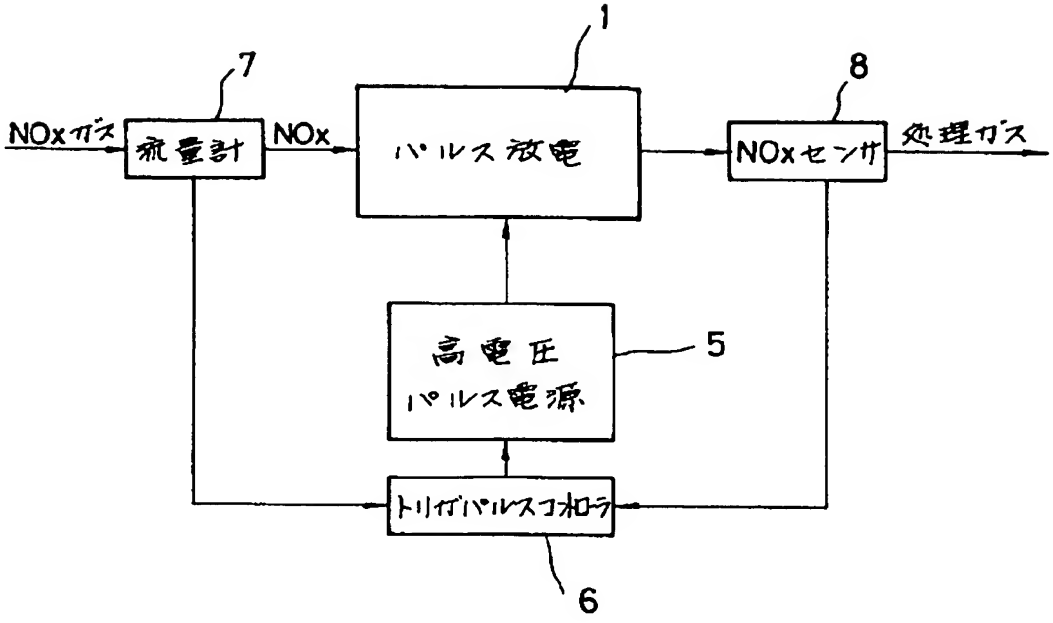
[Drawing 1]



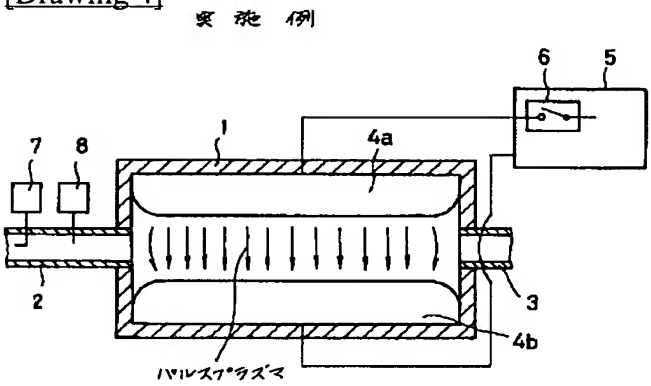
[Drawing 2]



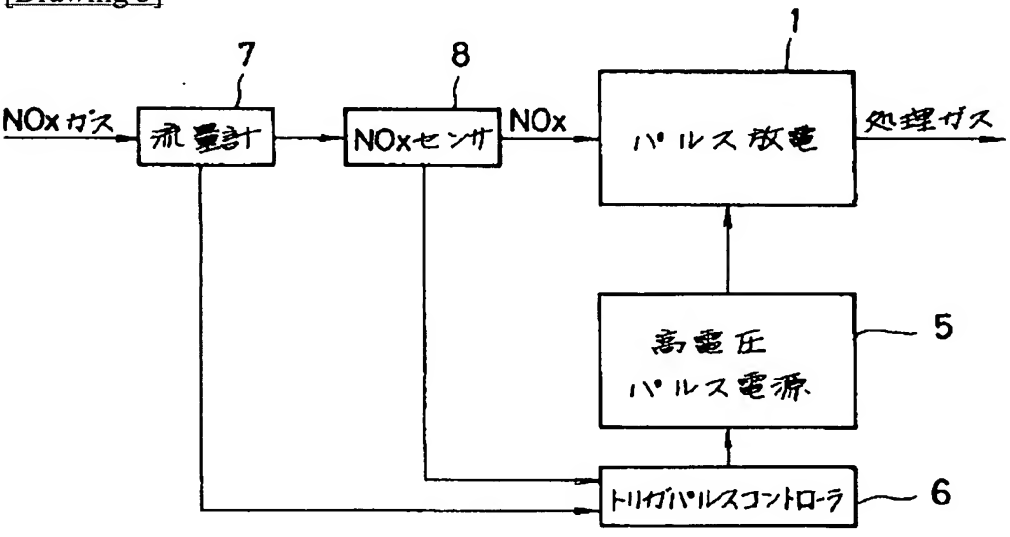
[Drawing 3]



[Drawing 4]



[Drawing 5]



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